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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/856,823	05/25/2001	Shin Hashimoto	0819-559	3480

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EXAMINER	
SONG, MATTHEW J	

ART UNIT	PAPER NUMBER
1765	

DATE MAILED: 02/12/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/856,823	Applicant(s) HASHIMOTO ET AL.	
	Examiner Matthew J Song	Art Unit 1765	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 28 August 2003.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-8 and 10-13 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-8 and 10-13 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 8/28.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 8/28/2003 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

3. Claims 1-8 and 10-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tung (US 5,728,625) in view of Sugano et al (US 4,469,527).

Tung discloses a process for forming an epitaxial cobalt silicide, where a thin layer of oxide **200** is formed on the surface of a silicon substrate **210**, this reads on applicants distributing a nonmetal element in a region in the vicinity of a surface portion a semiconductor layer (col 5, ln 20-50). Tung also discloses a cobalt layer **220** formed over the oxide layer using e-beam evaporation (col 5, ln 55-67) and after the cobalt layer is formed on the substrate, the substrate is annealed for an amount of time that is sufficient to convert the cobalt to cobalt silicide (col 6, ln 10-30). Tung also discloses a silicon dioxide film can be removed by ion etching (col 7, ln 15-21) and forming a gate electrode **308**, a source **311** and a drain **312**.

Tung does not disclose distributing a nonmetal element composed of an oxygen element, a nitrogen element or a fluorine element in a region in the vicinity of a surface portion of a semiconductor layer.

In a method of making a semiconductor device, Sugano et al teaches a silicon substrate having a silicon oxide film on the surface thereof was irradiated with thermal neutron beams with thermal neutron beams or other types of irradiation such as high speed neutron beam, α ray, β ray, γ ray, electron beam or the like, so that lattice defects were produced throughout the silicon substrate to make it semi-insulating (col 2, ln 50-61, col 11, ln 60-67 and col 12, ln 1-5). Sugano et al also teaches the surface of the silicon substrate was annealed by irradiating it with laser beam pulses, so that an activated layer was formed at the surface portion of the silicon substrate and the activated

layer was exposed by removing the silicon oxide (col 12, ln 5-35). Sugano et al also teaches an ion beam can be used in place of the laser beam (col 2, ln 50-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Tung with Sugano et al's semiconductor substrate because the electrostatic capacitance of the semiconductor device relative to ground is reduced, which shortens the delay time due to electrostatic capacitance, whereby the operative frequency band width is broadened and the operating speed is increased ('527 col 2, ln 14-32).

The combination of Tung and Sugano et al teaches a compound layer of silicon dioxide and an ion beam to form an activated layer at a surface portion of the silicon substrate. The combination of Tung and Sugano et al is silent to distributing a non-metal element composed of an oxygen element, a nitrogen element or a fluorine element in a region in the vicinity of the surface portion of the semiconductor layer through recoil by irradiating the compound layer with a particle energy beam, but it is inherent to the combination of Tung and Sugano et al because the combination of Tung and Sugano et al teaches a similar irradiation of the compound layer with a particle beam, as applicant. The combination of Tung and Sugano et al teaches removing a compound layer, thereby exposing the activated layer.

Referring to claim 4, the combination of Tung and Sugano et al teaches the same semiconductor layer, semiconductor-metal layer and compound layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure and the compound layer is amorphous.

Referring to claim 5, the combination of Tung and Sugano et al teaches an ion beam, but is silent to the beam including a nonmetal element. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Tung and Sugano et al by including a nonmetal element such as argon.

Referring to claim 6, the combination of Tung and Sugano et al teaches the same semiconductor layer and semiconductor-metal layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure.

Referring to claim 7, the combination of Tung and Sugano et al teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures. It is inherent that the semiconductor layer has a diamond or zinc blend structure and the semiconductor-metal layer has a calcium fluoride structure because the combination of Tung and Sugano et al teaches the same layers as applicant.

4. Claims 1-8 and 10-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Maa et al (US 5,830,775) in view of Sugano et al (US 4,469,527).

Maa et al discloses a gate structure **30**, a source **46** and a drain **48** on opposite side of the gate on a substrate **10**, where after the formation of the gate structure and implantation steps to create the source and drain, a layer of silicidation material **80** is deposited on the substrate. Maa et al also discloses the silicidation material is a uniform layer of Cobalt (col 4, ln 5-67). Maa et al also discloses a rapid thermal annealing, where the silicidation material reacts with areas of surface silicon to yield a silicon deficient

silicide product of CoSi (col 5, ln 5-40). Maa et al also discloses removal of oxide from a silicon deficient silicide region by in-situ argon ion beam cleaning (col 6, ln 55-65).

Maa et al does not disclose distributing a nonmetal element composed of an oxygen element, a nitrogen element or a fluorine element in a region in the vicinity of a surface portion of a semiconductor layer.

In a method of making a semiconductor device, Sugano et al teaches a silicon substrate having a silicon oxide film on the surface thereof was irradiated with thermal neutron beams, so that lattice defects were produced throughout the silicon substrate to make it semi-insulating (col 11, ln 60-67 and col 12, ln 1-5). Sugano et al also teaches the surface of the silicon substrate was annealed by irradiating it with laser beam pulses, so that an activated layer was formed at the surface portion of the silicon substrate and the activated layer was exposed by removing the silicon oxide (col 12, ln 5-35). Sugano et al also teaches various types irradiation other than thermal neutron beam can be used, such as electron beam and a high-speed neutron beam. Sugano et al also teaches an ion beam can be used in place of the laser beam (col 2, ln 50-67).

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Maa et al with Sugano et al's semiconductor substrate because the electrostatic capacitance of the semiconductor device relative to ground is reduced, which shortens the delay time due to electrostatic capacitance, whereby the operative frequency band width is broadened and the operating speed is increased (col 2, ln 14-32).

The combination of Maa et al and Sugano et al teaches a compound layer of silicon dioxide and an ion beam to form an activated layer at a surface portion of the silicon substrate. The combination of Maa et al and Sugano et al is silent to distributing a

nonmetal element composed of an oxygen element, a nitrogen element or a fluorine element in a region in the vicinity of the surface portion of the semiconductor layer through recoil by irradiating the compound layer with a particle energy beam, but it is inherent to the combination of Maa et al and Sugano et al because the combination of Maa et al and Sugano et al teaches a similar irradiation of the compound layer with a particle beam. The combination of Maa et al and Sugano et al teaches removing a compound layer, thereby exposing the activated layer.

Referring to claim 3, the combination of Maa et al and Sugano et al teaches a compound layer of silicon dioxide and an ion beam to form an activated layer at a surface portion of the silicon substrate. The combination of Maa et al and Sugano et al is silent to distributing a non-metal element included in the compound layer in the region in the vicinity of the surface portion of he semiconductor layer through recoil by irradiating the compound layer with a particle energy beam, but it is inherent to the combination of Maa et al and Sugano et al because the combination of Maa et al and Sugano et al teaches a similar irradiation of the compound layer with a particle beam. The combination of Maa et al and Sugano et al teaches removing a compound layer, thereby exposing the activated layer and oxide removed by an argon ion beam.

Referring to claim 4, the combination of Maa et al and Sugano et al teaches the same semiconductor layer, semiconductor-metal layer and compound layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure and the compound layer is amorphous.

Referring to claim 5, the combination of Maa et al and Sugano et al teaches an Ar ion beam.

Referring to claim 6, the combination of Maa et al and Sugano et al teaches the same semiconductor layer and semiconductor-metal layer as applicant, therefore it is inherent that the semiconductor layer has a face centered cubic crystal structure and the semiconductor-metal compound layer has a face centered cubic structure.

Referring to claim 7, the combination of Maa et al and Sugano et al teaches the same semiconductor layer, Silicon, and semiconductor-metal compound layer, cobalt silicide, but is silent to their crystal structures. It is inherent that the semiconductor layer has a diamond or zinc blend structure and the semiconductor-metal layer has a calcium fluoride structure because the combination of Maa et al and Sugano et al teaches the same layers as applicant.

Referring to claim 12, the combination of Maa et al and Sugano et al teaches forming a silicon oxide layer on a silicon substrate and irradiating the silicon oxide film with an ion beam, where it is inherent that the oxygen is distributed in the vicinity of the surface portion of the silicon layer. The combination of Maa et al and Sugano et al teaches also teaches removing the oxide to expose the activated layer.

Response to Arguments

5. Applicant's arguments filed 8/28/2003 have been fully considered but they are not persuasive.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies

(i.e., distribute the nonmetal element inside the surface of the semiconductor (pg 8, ln 22-23)) are not recited in the rejected claim(s). Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993).

Applicant's arguments against the Sugano reference are noted but are not found persuasive. Applicant alleges that inherency position taken by the Examiner is inconsistent with USPTO practice regarding the establishment of a proper case of inherency. MPEP 2112 states the Examiner must provide **rationale** or evidence tending to show inherency. As previously stated, Sugano et al teaches similar irradiation of a compound layer with a **particle** beam. Applicant's specification teaches irradiation with a particle energy beam, such as an Ar ion beam and is not limited to only an Ar ion beam (pg 27, ln 18-25). Therefore, because Sugano et al teaches a similar compound layer and irradiation with a particle beam, as applicant, one of ordinary skill in the art would expect a similar method to result in a similar distribution of nonmetal elements. The Examiner has provided rationale for inherency; therefore the burden shifts to the applicant to show an unobvious difference, as required by MPEP 2112. Applicant alleges that the neutron beam of Sugano, which is not the same as the instantly disclosed Ar beam irradiation process. Applicant broadly teaches irradiating with a particle beam and discloses a specific embodiment using an Ar ion beam (pg 27, ln 18-25); therefore distribution can be performed a particle beam. Sugano et al teaches irradiation with a thermal neutron beam, a high speed neutron beam, α ray, β ray, γ ray, electron beam or the like (col 2, ln 50-65). Sugano et al teaches using a particle beam and is open to other forms of

irradiation, such as an Ar ion beam, which would be expected to be capable of forming lattice defects, as evidenced by Minato (US 6,100,575) below.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Maa et al and Tung et al are not relied upon to teach the feature of distribution of a nonmetal element in the region in the vicinity of the surface portion of the semiconductor layer, this feature is taught by Sugano et al.

Conclusion

6. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Sun et al ("Impact of Nitrogen (N_2+) Implantation into Polysilicon Gate on Thermal Stability of Cobalt Silicide Formed on Polysilicon Gate") teaches a nitrogen implantation into poly-Si before the formation of cobalt silicide, which is formed by depositing a Co film followed by a silicon film and annealed (pg 1912-1913 II. Device Fabrication).

Sun et al ("Suppression of Cobalt Silicide Agglomeration Using Nitrogen Implantation ») teaches implanting Si wafers with nitrogen and forming a cobalt silicide by growing a Co layer, a silicon layer and annealing (pg 163).

Sakakibara et al (US 4,819,037) teaches implanting oxygen ions into a substrate to form a layer of good crystal property and forming a metal film, which is annealed to form an epitaxial silicide (col 4, ln 1-65).

Zhou et al (US 6,017,826) teaches a silicon oxide layer is irradiated with a neutral beam, such as an argon beam (col 2, ln 15-45).

Minato (US 6,100,575) teaches radiation such as an electron beam, proton beam, neutron beam, helium beam or Ar ion beam to cause radiation defects, such as lattice defects (col 4, ln 50-67).

7. All claims are drawn to the same invention claimed in the application prior to the entry of the submission under 37 CFR 1.114 and could have been finally rejected on the grounds and art of record in the next Office action if they had been entered in the application prior to entry under 37 CFR 1.114. Accordingly, **THIS ACTION IS MADE FINAL** even though it is a first action after the filing of a request for continued examination and the submission under 37 CFR 1.114. See MPEP § 706.07(b). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the

advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

8. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 571-272-1468. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1465. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Matthew J Song
Examiner
Art Unit 1765

MJS

NADINE G. NORTON
SUPERVISORY PATENT EXAMINER